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Fostering Innovation in Chile

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FOSTERING INNOVATION IN CHILE

ECONOMICS DEPARTMENT WORKING PAPERS No. 454

By
José-Miguel Benavente, Luiz de Mello and Nanno Mulder

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ABSTRACT/RÉSUMÉ

Fostering innovation in Chile

A good framework for investment in innovation can contribute to increasing Chile's growth potential. Spending on R&D is currently low in relation to GDP and heavily reliant on government financing. Innovation activity in the business sector is also limited by insufficient seed and venture capital and human capital constraints. This is despite several favourable framework conditions, including a stable macro-economy, liberal foreign trade and investment regimes, and reasonably pro-competition regulations in product markets. The government intends to increase public spending on R&D, to be financed by revenue from the mining tax introduced in May 2005, and to create a National Innovation Council. The effectiveness of these measures will depend largely on the extent to which they will boost business-financed innovation consistent with Chile's comparative advantages.

This Working Paper relates to the 2005 OECD Economic Survey of Chile (www.oecd.org/eco/surveys/chile)

JEL Classification: I20, O30, O54
Keywords: Chile, Research and Development, innovation policy

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Encourager l'innovation au Chili

Un bon cadre pour l'investissement en innovation peut contribuer à augmenter le potentiel de croissance du Chili. La dépense en R&D par rapport au PIB est actuellement basse et financée principalement par l'État. L'activité d'innovation dans le secteur privé est également limitée par l'insuffisance du capital risque, des capitaux de démarrage et du capital humain. C'est en dépit de plusieurs conditions générales favorables, y compris un environnement macroéconomique stable, un régime commercial et d'investissement libéral et des régulations favorables à la concurrence sur des marchés de biens. Le gouvernement prévoit d'augmenter les dépenses publiques en R&D, financées par le revenu d'une nouvelle taxe minière introduite en mai 2005, et de créer un Conseil national d'innovation. L'efficacité de ces mesures dépendra en grande partie s'ils encouragent l'innovation financée par les entreprises sur la base des avantages comparatifs du Chili.

Ce Document de travail se rapporte à l'Étude économique de l'OCDE du Chili, 2005 (www.oecd.org/eco/etudes/chili).

Classification JEL: I20, O30, O54
Mots-clés: Chili, Recherche et Développement, politique d'innovation

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Fostering innovation in Chile

by

José-Miguel Benavente, Luiz de Mello and Nanno Mulder[1]

1. Introduction

Boosting innovation is one of the government's priorities to lift Chile's growth potential, affecting not only labour productivity but also the efficiency with which inputs are combined. Chile already fulfils a number of framework conditions to boost innovation activity. Macroeconomic performance has been strong, with stable inflation and low real interest rates. FDI legislation is relatively investor-friendly. Product market regulations are reasonably pro-competition. Chile's liberal trade regime also facilitates access to foreign technology embedded in imported capital goods and inputs, which are important conduits for the diffusion of technology. Nevertheless, Chile's innovation performance leaves much to be desired by OECD standards, and even in relation to countries with comparable levels of income.

Against this background, this paper discusses the main obstacles to innovation activity in Chile and proposes corrective measures. The paper argues that the level of R&D spending is low and heavily reliant on government funds, owing in part to the fact that risk and venture capital markets are relatively underdeveloped in Chile. At the same time, innovation policy is formulated and implemented in a fragmented manner, which is not conducive to longer-term, strategic planning. Skilled workers and researchers are also in short supply.

This paper is structured as follows. Section 2 assesses Chile's innovation performance from an international perspective. Chile's main strengths and weaknesses are discussed in Section 3. Section 4 elaborates on the policies that could be put in place to remove the existing obstacles to innovation.

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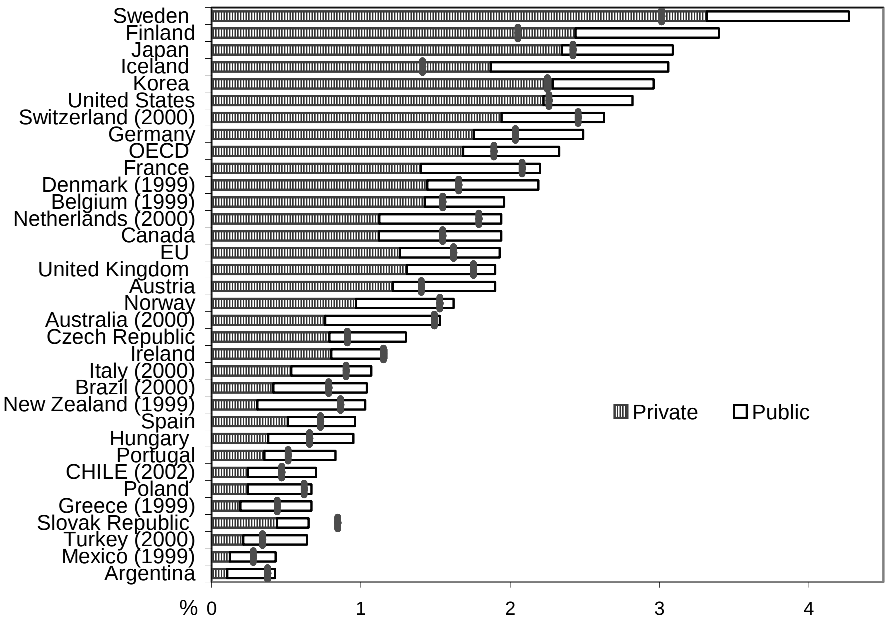
1. This paper was originally prepared for the OECD's 2005 *Economic Survey of Chile*. José-Miguel Benavente is professor at the Department of Economics of the University of Chile. Luiz de Mello and Nanno Mulder are, respectively, senior economist and economist in the OECD's Economics Department. The authors would like to thank without implicating officials from the Chilean government for the information provided, in particular Claudia Contreras (PBCT), as well as Val Koromzay, Andrew Dean, Silvana Malle, Peter Jarrett, Jean Guinet, Martin Schaaper and Rolando Avendaño, for helpful comments and discussions. Thanks are also due to Jocelyn Olivari and Anne Legendre for technical assistance and Mee-Lan Frank for technical preparation.

2. Innovation activity and performance

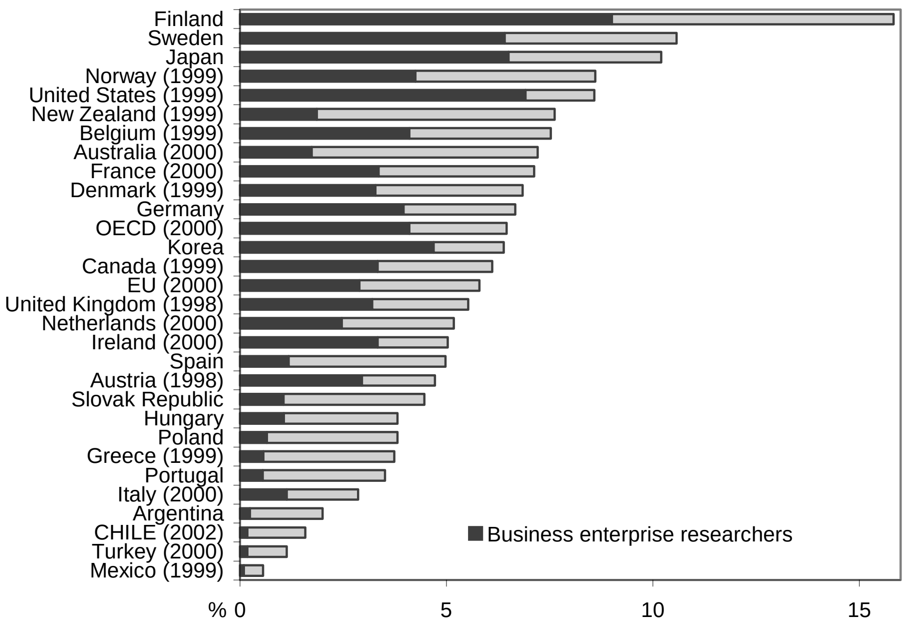
Chile’s spending on R&D, at 0.7% of GDP in 2002, is low in comparison with OECD countries, but not out of line with Latin American comparators, except Brazil (Figure 1). R&D intensity is a key

Figure 1. **R&D intensity and number of researchers: Argentina, Brazil, Chile and OECD countries, 2001**

A. R&D intensity (in % of GDP)[1]



B. Researchers (per thousand total employment)



1. The dots correspond to the levels in 1995.

Source: CONICYT, RICYT, and OECD, Main Science and Technology Indicators database.

input to innovation and one of the most widely used indicators to compare innovation activities in different countries. Unlike the OECD area, where R&D intensity has risen steadily since the 1980s, spending on R&D has remained fairly stable over time in Chile.[2] Consistent with this, the share of R&D personnel in total employment, another key input to the innovation process, is also comparatively low, with almost 90% of R&D personnel working in public research institutions. In contrast, in most OECD countries, R&D personnel account for a substantially higher share of employment, and the majority works in the business sector.

As in the rest of Latin America, most R&D spending is financed by the government in Chile. This runs counter to OECD-wide trends, where innovation is financed and carried out primarily by businesses. Preliminary estimates for 2003 suggest that about 70% of R&D spending in Chile is on applied research, including experimental activities. While a case can be made for public funding for basic research on the grounds that there may be limited scope for immediate commercial use for these innovations, which may take time to come to fruition, there is also the issue of whether larger gains could be achieved by allocating more funds to applied research. Almost two-thirds of public spending on R&D in 2002-04 was allocated to higher-education institutions and related funds, and linked to the Ministry of Education (Annex A1).

Variations across countries in R&D intensity tend to reflect income differentials. But Chile's gap in relation to the OECD average cannot be ascribed to an income gap alone: R&D intensity is lower in Chile than in countries with lower income *per capita,* such as China and India. This suggests significant scope for catching up, although it should be noted that, to a large extent, R&D intensity tends to be lower in resource-based economies.[3] This is the case even among OECD countries, where business R&D intensity is considerably lower than the area-wide average in countries such as Australia and Norway. An additional caveat is that R&D-related indicators are an imperfect measure of innovative performance.[4] Many other types of expenditure, such as fixed investment and labour training, are not conventionally recorded as R&D but also contribute to the successful commercial development of innovations. Moreover, indicators of R&D intensity may not reflect the productivity of the resources used, particularly if returns to scale are not constant and/or market competition is imperfect. The limitations of input measures as proxies for innovation underline the importance of looking at direct output measures.

Consistent with relatively low R&D intensity, the output of innovation activity appears to be low. Chileans hold relatively few patents abroad and have a poor record of scientific publications, which are conventional measures of innovation output (Figure 2). This is in line with OECD trends, where the numbers of patents *per capita* is positively correlated with business R&D intensity. The share of new products in business turnover provides a further measure of innovation performance, but information is not readily available for Chile on an internationally comparable basis. Again, it should be noted that the number of patent holdings is an imperfect measure of innovation output, because many inventions may go unpatented or can be protected by trademarks, design registrations and copyrights, and companies often keep commercially sensitive information secret.

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2. See OECD (2005*a*), for more information.

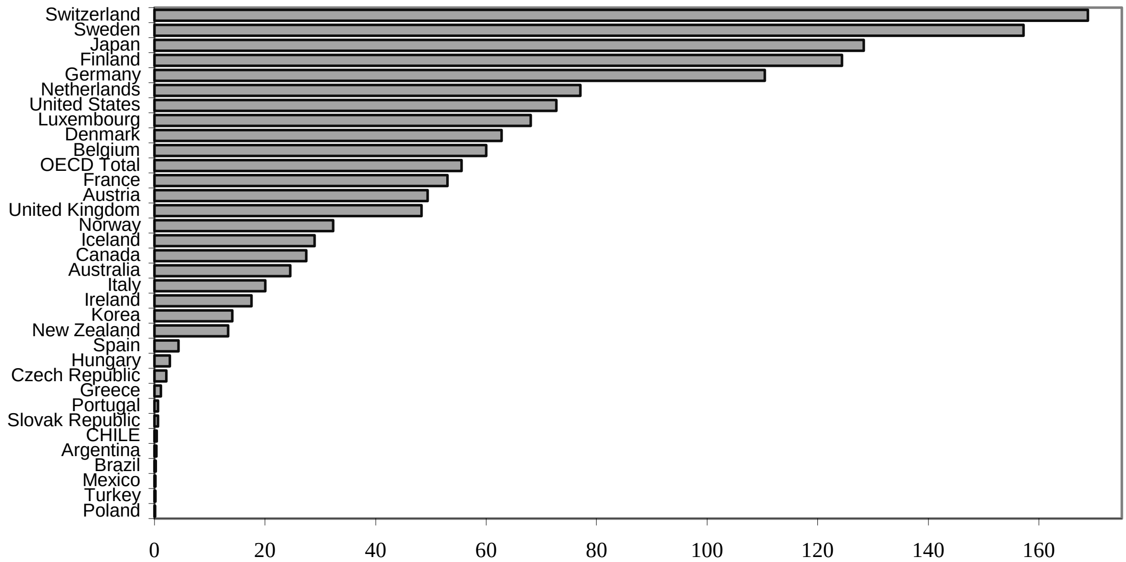
3. Sheenan and Wykoff (2003) show that R&D intensity is strongly correlated with production structure. In high R&D-intensity countries, such as Finland, Germany, Japan, Switzerland and the United States, most business R&D is spent, and output is produced, in high-technology sectors. In low R&D-intensity countries, such as Australia, Iceland and Norway, high-tech industries account for only a small share of output. See also Mullin *et al*. (1999).

4. See Holm-Nielsen and Agapitova (2002), for more information. In 2002, a first national census of private R&D showed spending to be 74% higher in real terms than in 2001, compared to an increase of 7% in the public sector over the period, which may be an indication that the private innovation effort had previously been underestimated.

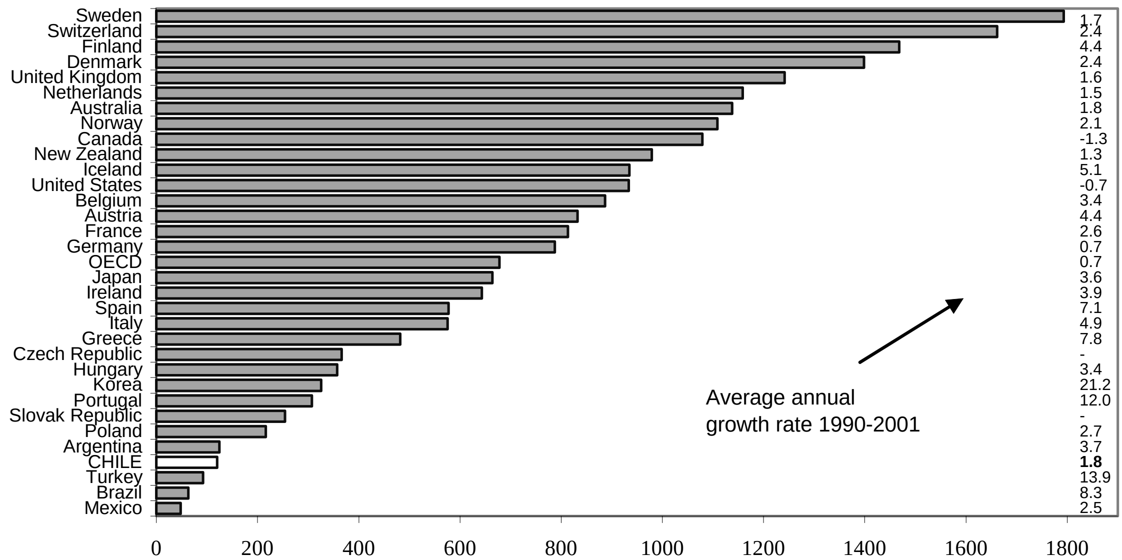
Chile fares slightly better in relation to some OECD countries and Latin American comparators in terms of ICT penetration, which is important for the diffusion of knowledge (Figure 3). Within Latin America, the country is among the most advanced, being particularly well placed in terms of the penetration of mobile phones, internet users and personal computers. Moreover, Chile is relatively (*Compras Chile*). But a significant gap remains in this area with respect to most OECD countries. The liberalisation of the telecom sector in 1982, along with the privatisation of telecom companies in 1988,

Figure 2. **Triadic patents and scientific publications: Argentina, Brazil, Chile and OECD countries, 1990-2001**
In millions of working-age population[1]

A. Triadic patents, 1998



B. Scientific publications in science and engineering, 2001



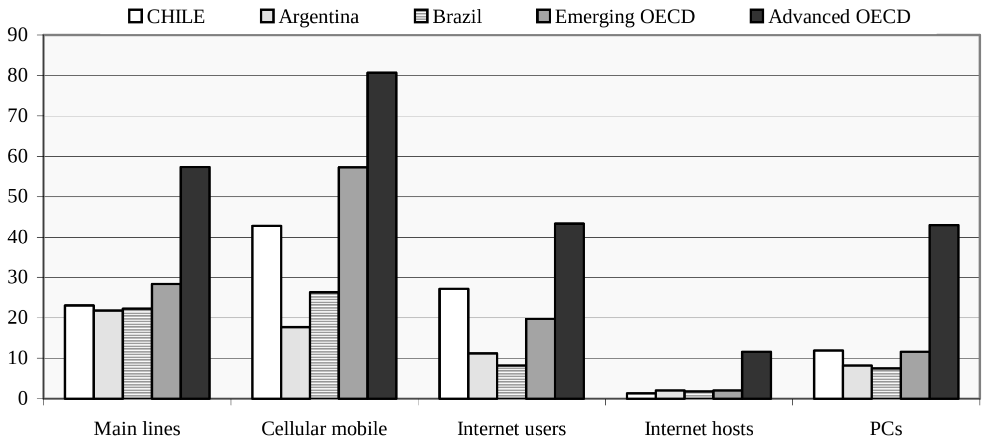
1. Patents are reported by inventor's country of residence and priority date, using fractional counting procedure.
Source: OECD, Patent Database, December 2004; Institute for Scientific Information, Science Citation Index and Social Science Citation Index: CHI Research, Inc., Science Indicators database; and National Science Foundation.

may have facilitated access to ICT by reducing costs, although access rates hide large discrepancies between high- and low-income households, and large and medium/small enterprises.[5]

Innovation activity is concentrated in large enterprises. Based on information available from the *2002 R&D Census* (covering all sectors of activity, except wholesale and retail trade), private R&D intensity, at 0.2% of GDP, was concentrated in less than 1% of firms (excluding micro-enterprises), with 26 large firms accounting for 60% of total expenditure. Three-quarters of R&D spending was carried out by firms in the metropolitan area of Santiago, which accounts for about one-half of all formally-registered firms in the country. In terms of the sectoral distribution of R&D intensity, most spending was in manufacturing (mainly pulp and paper products, wood and furniture, and food and beverages), transport, and agriculture (Figure 4) – areas where Chile has comparative advantages. Business R&D is carried out by about a thousand scientists and another thousand technicians, concentrated in the largest firms.

Motivation to innovate differs across sectors. Information available from the *2000-01 Innovation Survey* (Annex A2) suggests that, in manufacturing, most innovative ideas come from within the firm, with the objective of improving working conditions, while in mining and electricity innovation is also motivated by environmental concerns. Acquiring external knowledge, at least as far as gauged by spending on royalties for the use of patented inputs, know-how transfers and licenses, played a minor role in all three sectors, except for a few large mining companies. Mining was most active in links with scientific and technological institutions, either directly, through contracts, or indirectly, through participation in seminars and co-authorship of scientific publications. Firm size and market characteristics also seem to affect the probability that a firm will innovate (Box 1).

Figure 3. **Penetration of information and communication technologies (ICT): Argentina, Brazil, Chile and OECD countries, 2003**
Units per 100 inhabitants

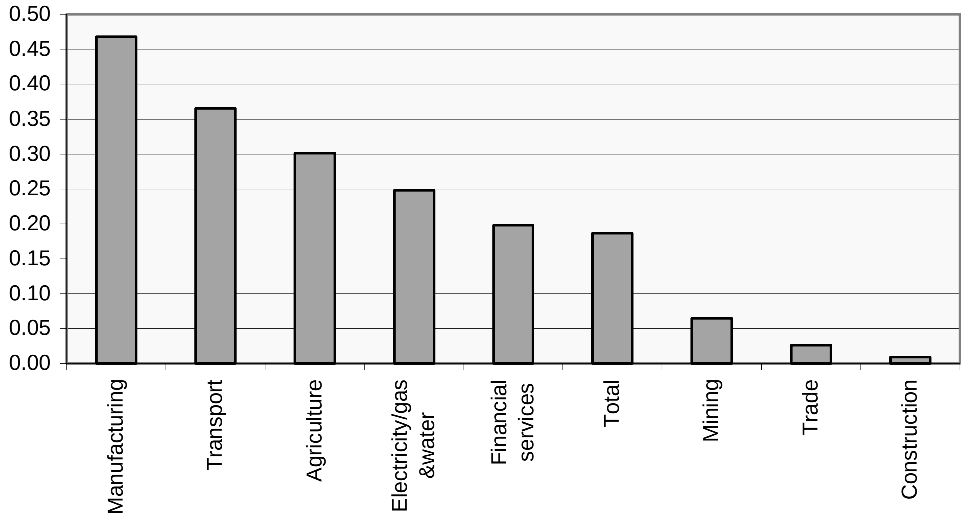


1. Emerging OECD refers to Czech Republic, Hungary, Mexico, Poland, Slovak Republic and Turkey; and advanced OECD refers to the remaining member countries.

Source: International Telecommunications Union.

5. Small enterprises face several constraints for ICT use: high costs of equipment, lack of understanding of potential benefits of ICT use and skill shortages. See World Bank (2004), for more information.

Figure 4. **R&D intensity, 2002**
Spending in % of value added



Source: Ministry of Economy (2004).

Box 1. **Determinants of innovation in manufacturing**

Empirical evidence, based on information available from the three Innovation Surveys carried out between 1995 and 2001, suggests that:

- The probability of undertaking innovation is positively related to plant size, the availability of ideas from within the firm, and the use of external consultants. Association with, or imitation of, competitors also has a positive impact on a firm's probability to innovate. In contrast, investment in machinery and equipment and spending on licenses do not seem to be affected by firm size.
- Spending on innovation tends to be higher in larger firms and those that are foreign-owned. The use of innovative ideas developed by public institutions has a negative effect on innovation spending, suggesting a substitution effect between public and private innovation. In contrast, public funding has a positive effect, suggesting that private and public financing are complementary.
- The probability that firms will introduce new products and processes is positively correlated with cumulated innovation spending per employee, more so in the case of new products than new processes. Domestic firms produced more new products and processes in the mid-1990s than foreign affiliates, but the opposite was true in 2001. The likelihood of introducing new products or processes depends in particular on links with public research institutions, the use of external consultants and the possibility of imitating competitors. Association with competitors does not increase the probability of product innovation.
- The share of new products in enterprise turnover depends positively on innovation spending but does not seem to be affected significantly by firm size, its export orientation, or how much it invests in machinery and equipment. The use of foreign licenses and foreign ownership has a negative impact.
- In the second half of the 1990s, labour productivity was not significantly linked to innovation, but in 2000-01 a significant positive effect was found, although smaller than that of physical capital.

Source: Benavente (2004*a*).

International comparison suggests that Chilean firms focus on adapting, rather than creating, new technologies. Again, this may reflect Chile's comparative advantages and level of development. More than four-fifths of spending on innovation was on machinery and equipment embodying new technology, whereas in the European Union (EU), based on the *1998-2000 Community Innovation Survey*, this share was around 40%. Consistent with that difference, intramural R&D accounted for 11% of spending on innovation, compared to over one-fifth in the EU. Labour training accounted for only 5% of innovation spending, compared to one-fifth in the EU. In Chile, the composition of innovation spending in mining and electricity was similar to that of manufacturing.

Survey data suggest that the major obstacle to innovation is economic, notably its costs and investment risk. Human resources are considered the second most important obstacle, including a shortage of skilled personnel and resistance on the part of employees to changing work practices. Based on the EU's *Community Innovation Survey*, the ranking of obstacles appears to be similar in Chilean and European firms. Nevertheless, despite the preponderance of deterrents of an economic nature, enterprises in the manufacturing sector appear to have made little use of public funding for R&D, accounting for less than 5% of total funds used to finance spending on innovation. Enterprises in mining and electricity did not use public funds at all, possibly due to access to financing, or reliance on technological transfers, from parent companies abroad. On average, financing tends to come predominantly from internal sources, with private external sources accounting for about one-quarter of the funds used to finance innovation. In the EU, by contrast, one-third of manufacturing firms made use of public funding for R&D. Links between public and private institutions create network externalities and therefore also have a positive impact on private innovation activity. Non-profit organisations, such as *Fundación Chile*, play an important role by facilitating access by domestic firms to foreign technologies in which the country has comparative advantages, such as the wine, salmon and fruit industries (Box 2).

Box 2. ***Fundación Chile***

Fundación Chile is the largest private non-profit organisation fostering innovation in Chile. Founded in 1976 by the Chilean government and the US ITT Corporation, its main goal is to transfer state-of-the-art technology, management techniques and human skills to natural resource-intensive sectors. To achieve its goals, *Fundación Chile* creates new companies and joint ventures, carries out R&D, adapts foreign technology for product and process innovation for client companies in the public and private sectors, and fosters the creation of technological consortia and the diffusion of technology to small and medium enterprises.

In recent years, *Fundación Chile* has focused on biotechnology (forestry genetics and DNA vaccines for aquaculture, among others), financial engineering and information (venture capital), and management. It has also supported the development of clusters in particular in sectors in which Chile is believed to have comparative advantages, such as agribusiness, eco-tourism, forestry and wood processing. Its activities in the areas of skill upgrading focus on life-long learning, long-distance education, the use of ICT in education and management in education. It has been successful with starting new ventures. By 1999, it had set-up 36 ventures, of which 17 had been sold. The six leading companies earned revenues surpassing the total cost of the *Fundación Chile* during its entire existence.

Source: www.fundacionchile.cl and Bitran (2002).

3. Fostering innovation: Chile's strengths and weaknesses

Chile has several strong framework conditions that favour the diffusion of innovation. The country's main strengths include macro-economic stability, competition-friendly product market regulations, and liberal foreign trade and investment regimes, including foreign direct investment (FDI) legislation.[6] Empirical evidence for OECD countries shows that strong output growth, low inflation, deep financial and equity markets, and pro-competition product market regulation are associated with higher R&D intensity.[7] Against this backdrop, the main issues that are addressed below are: *i)* direct government support is delivered in a fragmented institutional setting that lacks a long-term strategic focus; *ii)* the seed and risk capital markets are underdeveloped; *iii)* there is a shortage of scientists and human capital is low; and *iv)* copyrights are poorly enforced.

3.1. Fiscal incentives

Chile's mix of instruments to promote innovation in the business sector is tilted towards direct government support. R&D spending is deductible against corporate income tax liabilities, as well as one-half of donations to universities. But the bulk of fiscal incentives comes from direct government support through a multiplicity of funds in an institutional setting that suffers from fragmentation and lacks a long-term strategic focus. Innovation funds are typically small and managed predominantly by the Ministries of Education and Economy (Figure 5 and Annex A1). The largest fund, FONDEF, managed by the Ministry of Education (CONICYT), aims at encouraging business innovation and fostering competitiveness in joint ventures with universities and technological institutes. Other important funds, FDI and FONTEC, are managed by the government's Economic Development Agency (CORFO).[8] In 2005, FDI and FONTEC were merged into a new programme: *Innova Chile*. Two smaller funds are FIA (Agrarian Innovation Foundation) and FIP (Fisheries Research Fund), managed by the Ministries of Agriculture and Economy, respectively. Access to government support is granted through public tenders. Projects are selected according to their economic impact, based on the objectives established by fund managers. All projects require private-sector partnership.

As illustrated by the manufacturing innovation surveys, access to public financing is considered cumbersome by businesses. Firms are often discouraged from applying, because they are reported not to know how to formulate a project proposal and fear that their ideas will leak to competitors. Moreover, some firms complain that fund managers and consultants do not have the technical expertise to evaluate projects, which may delay the application process. Another disincentive is that, once a project is approved,

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6. Empirical evidence suggests that exporters in the manufacturing sector are more likely to engage in product and process innovations than non-exporters. See Alvarez and Robertson (2004), for more information.

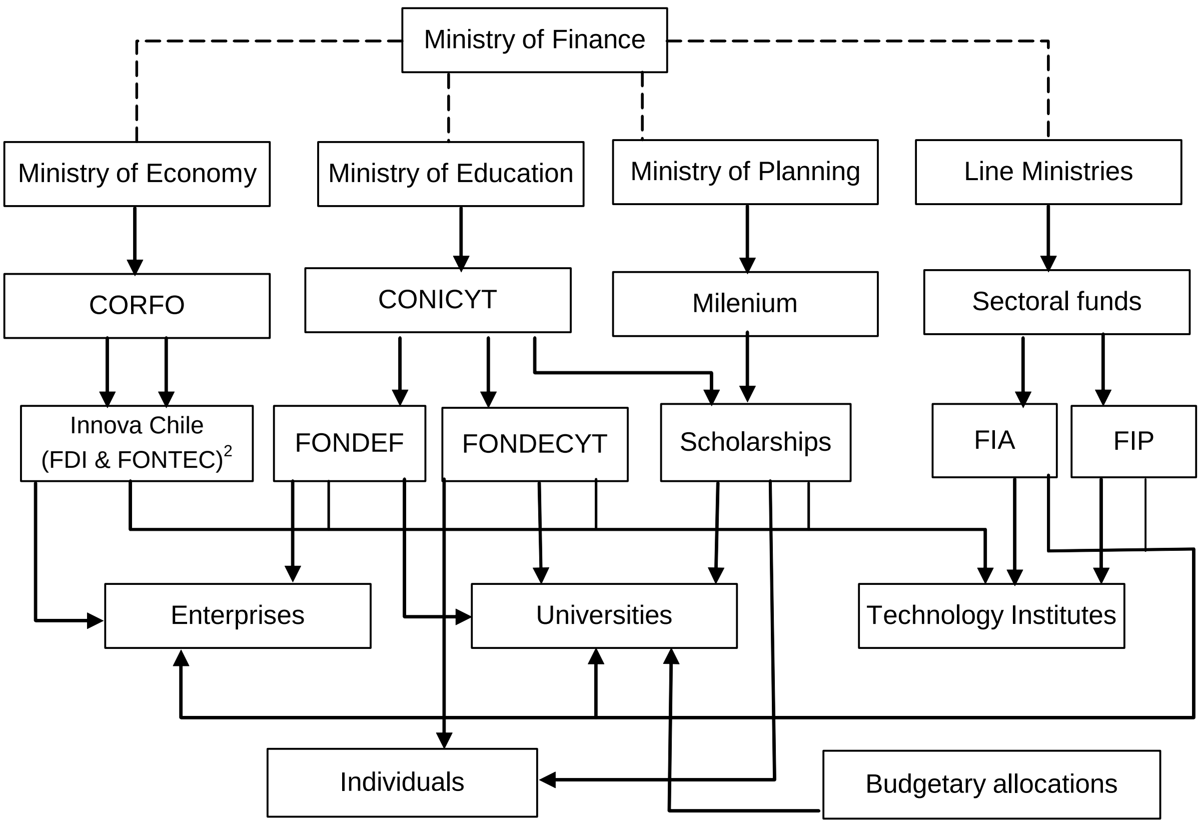
7. For product markets, theory predicts that when competition rises from a low level, potential competitors have an incentive to innovate to converge to, or supersede, the technologies used by incumbents. At high levels of competition, expected rents from new innovations may be low and discourage incumbents from carrying out R&D. In the case of employment protection legislation (EPL), high protection may create mismatches in the demand and supply of researchers and wage pressures, thereby discouraging restructuring at the enterprise level, which may be needed to incorporate new technologies. At the same time, high protection reduces labour turnover and allows firms to better use specific skills which in turn favour innovation. See OECD (2005*a*), for more discussion and empirical evidence for OECD countries.

8. FONTEC covers up to one-half of project costs and provides financing for projects related to technology transfer, innovation, infrastructure and management training. FDI co-finances investment projects and supports business start-ups. Co-financing is offered for the development and adoption of new (and cleaner) technologies and technology diffusion. Support for new businesses is provided in the form of promoting business alliances, incubator programmes and venture capital. See World Bank (2004) and OECD (2005*c*), for more information.

fund managers decide on the timeframe for execution, which may not match that of the firm. An additional shortcoming often mentioned by firms is the lack of information on public resources available to promote innovation.

Fragmentation in the delivery of government support renders policy coordination and long-term planning difficult. In principle, a co-ordinating role is attributed to the Ministry of Education (CONICYT); in practice, however, several ministries carry out their own R&D activities and, to a large extent, formulate their own policies. In addition, the fragmentation of public funds precludes potential economies of scale and scope, and creates overlapping mandates. This is clearly detrimental to the efficient allocation of scarce budgetary resources. For example, FDI and FONDEF often cater to a similar client base and seek to overcome comparable market failures (Annex A3).[9]

Figure 5. **Institutional set-up of public support for R&D**[1]



1. Annex A3 describes the individual funds.
2. FDI and FONTEC were merged in 2005 into Innova Chile.

9. Other examples of overlapping mandates are the Millenium Initiative and FONDECYT, the Knowledge Economy Science Programme and the *Chile Innova* programme, and among FIA, FIP, FDI and FONTEC.

Co-operation between businesses and research institutions is weak, discouraging the creation of network externalities, which are important determinants of innovation. Information available from the *2000-01 Innovation Survey* suggests that less than 5% of manufacturing firms co-operate with universities. This may be due to the fact that academic research is insufficiently adapted to firms' needs, and that many researchers may be reluctant to co-operate with the business sector. Many firms may also be unable or unwilling to adopt or find commercial use for new technologies. Co-operation is weak even in resource-intensive sectors, where the existence of government-funded technological institutes could facilitate the diffusion of technology to the business sector and foster co-operation with, and among, firms.[10] An evaluation illustrates that firms that do co-operate with universities spend almost twice as much on R&D, engage in more product and process innovations, and have higher labour productivity growth.[11]

3.2. Risk and seed capital

The risk and seed capital markets are shallow. These instruments are important to fund risky innovation projects, particularly for entrepreneurs at an early stage of the R&D process, having no record of successful research undertakings, limited access to external funds and facing internal financing constraints. The development of the venture capital industry is hindered by the low liquidity of the capital market, which reduces exit options for venture capital investors; restrictions on the exit of foreign capital, such as the requirement that foreign equity investment must remain in Chile for at least 1 year, which may discourage entry;[12] prudential regulations on pension and mutual fund investment in venture capital, which reduces the investment pool; insufficient competition in the financial sector; and the country's small size and geographical remoteness, which may discourage foreign investors. To some extent, the preponderance of government financing for innovation may be crowding out equity financing. Based on a survey conducted by a NGO in 2003, of the USD 38 million of funds available for new business ventures and projects in 2002, 87% were public.[13] This included FONDEF and CORFO, through FONTEC and its Seed Capital Programme.[14] The main private funds in 2002 were *Fundación Andes*, *Negocios Regionales* and *Santiago Innova*.

Demand factors, not only supply constraints, have contributed to the relative underdevelopment of venture capital. Anecdotal evidence suggests that there is a lack of high-quality projects because Chile's economy is small and resource-based, and has low R&D intensity.[15] Another impediment is the traditional ownership structure in the business sector: firms are unwilling to grant special rights to minority shareholders, which is essential to venture capital, and stock options are not widespread as a means of

10. The main ones are: Metallurgical and Mining Research Centre (CIMM), Natural Resource Research Centre (CIREN), Fisheries Promotion Institute (IFOP), Forestry Institute (INFOR), and Agriculture and Livestock Research Institute (INIA). See Rivas (2004*a*), for an assessment of these institutions.

11. See Benavante (2004*b*), for more information.

12. According to Art.4 of *DL 600*.

13. See Fundes (2003), for more details.

14. This programme promotes the creation of new businesses at the incubator and start-up stages using new or emerging technologies. It funds up to CLP 35 million per undertaking. Between 2001 and mid-2003, it funded 43 projects (out of 150 applications), amounting to CLP 1 billion, mostly related to ICT, but also foodstuffs and health care. The evaluation of projects is outsourced to private consultants on risk capital (*patrocinadores*) following pre-selection by CORFO in a process that is considered burdensome and inefficient. According to CORFO executives, *patrocinadores* have difficulty in assessing the projects' risks and potential. As *patrocinadores* are paid for the execution of approved projects, but not for the evaluation of project proposals, they have shifted the burden of project evaluation to CORFO (Rivas, 2004*b*).

15. See Rivas (2004*b*), for more information.

labour compensation.[16] New businesses are typically financed with credit from family or friends, and when their venture matures, they switch to bank financing, skipping the intermediate steps of equity financing through seed and venture capital. This is at odds with OECD trends, where equity financing became more important relative to bank credit during 1996-2000.

Policy initiatives to foster the development of venture capital have so far focused on capital market regulations, as discussed in the *2003 Survey*. In 1989 pension funds were allowed to invest 5% of their assets under management in FIDES (Investment Funds for Enterprise Development). Mutual funds were allowed to invest 10% of their assets in FIDES in 2000 (*Ley de OPAS*).[17] The 2002 capital market reform created a new stock market for emerging companies, eliminated taxes on capital gains for high-turnover stocks and for short sales of bonds and stocks, reduced tax for international financial transactions and strengthened minority shareholder rights.

Recent initiatives to develop venture capital include the Capital Market Reform, *MK II*, currently in Congress. The main aspects of this reform are as follows. *First*, tax incentives would be granted, including the introduction of a capped exemption from income taxation of the capital gains on equity holdings of firms where capital funds participate with at least 20% of the firm's capital and for a minimum of one and a half year. *Second*, a new type of corporation of limited liability would be created, facilitating the participation of venture capitalists.[18] *Third*, CORFO would be authorised to invest in venture capital funds through quotas (currently, CORFO can only lend to those funds). *Finally*, legal barriers to the management of small companies by the venture capital fund managers would be lifted. To encourage demand for venture capital, government initiatives include CORFO's National Incubator Programme for private firms with the obligatory participation of universities or technological institutes.[19] *Fundación Chile* would also foster ventures among risk capital investors.

3.3. Enrolment in higher education

Innovation is hampered by a lack of human capital. This is despite the rapid increase in the enrolment rate in higher education over the last decade, from 14% to 28% between 1990 and 2002.[20] Enrolment in post-tertiary education also expanded rapidly, and the number of Masters and PhD degrees increased almost five-fold during 1991-2001.[21] Nevertheless, tertiary and post-tertiary enrolment remains low compared to OECD countries. Also, the quality of higher-education institutions is heterogeneous, and vocational training schools often operate with outdated curricula. To improve quality, in 1999 the Ministry of Education started an accreditation programme for higher-education institutions on a voluntary basis. By February 2005, 62 institutions were participating, covering 85% of the students in higher education, of

16. See World Bank (2004), for more information.

17. See p. 99 of *Ley de OPAS* (www.svs.cl).

18. This type of co-operation would allow for example minority shareholder to impose certain decisions. See Rivas (2004*b*, p. 22), for more information. Empirical evidence for OECD countries suggests that financial sector development, stock market capitalisation and the share of corporate profits in GDP all have a positive impact on R&D. See OECD (2005*a*), for more information.

19. The programme finances up to 60% of project costs for up to three years and a maximum of USD 250 thousand, including 8 incubators (63 projects).

20. In May 2004, there were 64 universities (of which 25 public), 48 professional institutes (all private) and 117 technical training centres. Graduate research is supported by CONICYT. See OECD (2004*a*) and World Bank (2004), for more information

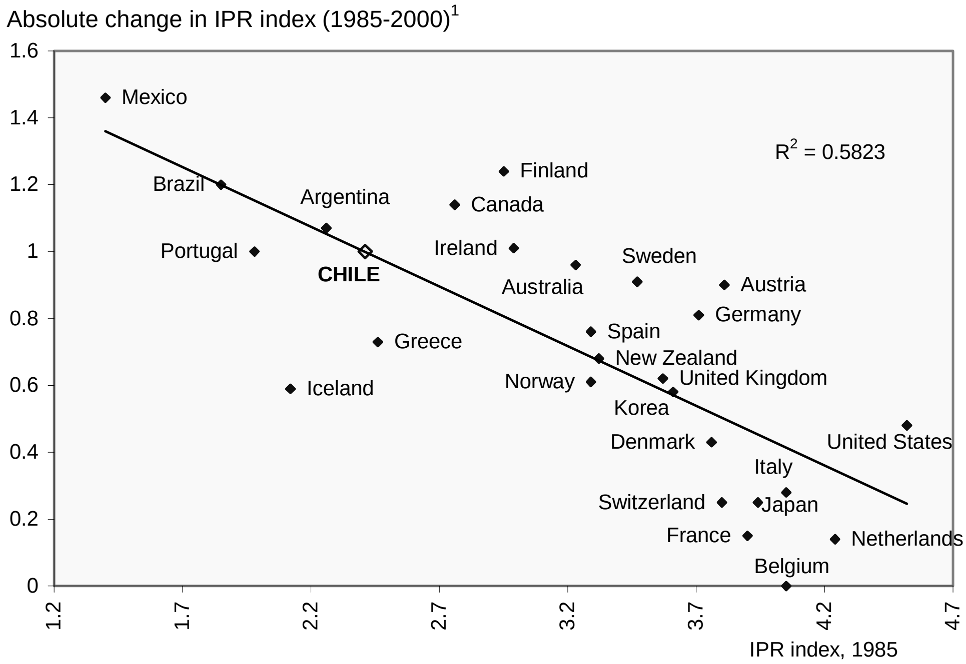
21. This refers to Masters and PhD degrees granted by the universities affiliated with *Consejo de Rectores*. For more information, see CONICYT (www.conicyt.cl).

which 19 have been accredited.[22] To improve access to higher education, especially among students from low- and middle-income households, the system for student loans is being upgraded with a new scheme.

3.4. IPR legislation and enforcement

A new law, expected to enter into force by mid-2005, is set to upgrade Chile's IPR legislation, in effect since 1991.[23] Copyright is regulated separately by the Copyright Law of 1992. The level of legal IPR protection is converging to the OECD average (Figure 6), although legislation had until now not covered trade secrets and confidential test data.[24] Legislation protecting plant and animal varieties was put in place in 1996. The enforcement of IPR legislation is complicated. During 2001-04, trade losses associated with copyright piracy in Chile alone are reported to have almost doubled to USD 107 million, in particular in the area of business and entertainment software.

Figure 6. **Convergence in intellectual property rights protection**



1. Based on the Park Index. A high score indicates stronger IPR protection.

Source: Park and Wagh (2002), Ginarte and Park (1997) and OECD (2005*a*).

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22. For more information, see *Comisión Nacional de Acreditación de Pregrado* (www.cnap.cl).

23. The new IPR law was approved by Congress in March 2005, but will not enter into force until issuance of specific regulations, expected by mid-2005. The 1991 law introduced standard proceedings for granting patents, trademarks, utility models, and industrial designs.

24. See International Intellectual Property Alliance (IIPA) (2005), for more information. In 2005, IIPA upgraded Chile from the "watch list" to the "priority watch list", highlighting the adoption of better anti-piracy measures following the approval of the new IPR law.

The new IPR law will bring Chilean IPR legislation into line with the requirements of the WTO's Trade Related Intellectual Property Rights Agreement (TRIPs).[25] The law's main provisions include protection for trade secrets, test data for pharmaceuticals, geographical and origin indications, and design of manufacturing products. Enforcement is expected to be improved, because it will be easier to: *i*) deal with IPR cases through civil, rather than criminal, proceedings; *ii*) file for compensation for losses caused by violations of the law; and *iii*) obtain court-sanctioned measures to prevent infringement repetition. Moreover, in civil cases concerning process patents, courts may now decide to reverse the burden of proof to the defendant when products manufactured by the patented method are new. Out of the 10 members of the special Court of Appeal for IPR disputes, created in 1991, at least 6 will need to be IPR specialists. The new IPR law also extends the payment period for patents, which should increase the incentive for patenting.

The effect on innovation of upgrading IPR legislation is uncertain. Some empirical evidence suggests a relationship between cross-country differences in patenting and in the strength of IPR protection. But evidence is also available to suggest that this link only exists when initial IPR protection is weak. Surveys show that IPR protection is only important in selected industries, such as pharmaceuticals and scientific equipment. Evidence for OECD countries suggests that stronger IPR protection increases patenting but has a limited effect on R&D.[26]

The number of patents filed in Chile is low, but appears to be trending upwards. In addition to a poor record in patenting abroad, relatively few patent applications are filed and approved in Chile: only 3 600 patents were approved during 1992-2000, which is about one-tenth of the number approved in Mexico, a regional comparator. The process of handling patent applications by the Industrial Patents Department of the Ministry of Economy is not considered overly time-consuming (less than 5 years during 1995-2003), or costly (currently about USD 760-860), although estimates vary considerably.[27] To speed up patent applications and to handle a larger number of applications, this department was allowed to more than double its staff in 2005.

4. Moving forward: How to boost innovation?

4.1. What to expect from further direct government support

Central to the government's policy agenda to boost innovation activity is an increase in direct support. The government intends to double public R&D spending from 0.4% to 0.8% of GDP in a phased manner over the next three years, to be financed by revenue from the new mining tax.[28] This will accentuate the current imbalance in the mix of instruments available for fostering innovation, which is already tilted in favour of direct government support. It should be noted that international experience suggests that properly designed tax incentives also contributes to boosting R&D intensity (Box 3), but there are no international "best practices" in this area. Simulations for Chile illustrate that the fiscal burden of tax incentives would be relatively small.[29]

25. As a developing country, Chile was allowed to postpone the harmonisation of national legislation to comply with TRIP provisions until 1 January 2000. However, legislation had not been approved until 2005.

26. See OECD (2005*a*), for more information.

27. See US Embassy in Santiago (2004) and World Bank (2004), for more information.

28. See Eyzaguirre *et al*. (2005), for more information.

29. See Benavente (2003), for more information.

Greater reliance on direct government support may run into governance problems. With increased sources of financing, the authorities may find it difficult to muster the necessary support in the research community for rationalising the existing funds with the aim of tackling fragmentation in the panoply of instruments for delivering government support. The increase in the availability of funds, although gradual over the near term, is also likely to place an additional burden on fund managers to adequately assess the merits of individual applications and the cost-effectiveness of their project portfolios against the policy objectives set by the government. The assessment of existing projects is already perceived as inadequate and will need to improve if the analysis of the cost-effectiveness of alternative policy instruments is to be carried out more thoroughly in the years to come.

Innovation policy, regardless of the support instruments used, should be consistent with Chile's comparative advantages. Scarce public funds should not be used to "pick winners". Direct government support will be effective to the extent that it targets firms facing limited access to external financing and with insufficient taxable income to make use of additional tax incentives, should these be introduced pending congressional approval of the Capital Market Reform (*MK II*) package. It is true that comparative advantages change over time, and Chile may already be close to the technological frontier in some niche areas. But innovation would have a higher pay-off in most sectors if it focused on the diffusion of state-of-the-art technologies adapted to business needs. This would favour support for the diffusion/adoption of general-purpose technologies with the broadest sectoral application possible, in particular information and communication technologies. Greater emphasis on support for applied research would be consistent with this objective. This emphasis has already guided the design of *Innova Chile*, the new private innovation support programme of the Ministry of Economy, but much remains to be done in other areas.

Box 3. **Fiscal incentives for R&D: The experience of OECD countries**

Many governments encourage innovation on the grounds of market failures due to high social, but often low private, rates of return. Conventional incentives include direct government support and tax relief for R&D expenditures. Direct support can be advocated on the grounds that innovation can be carried out by small firms that have little taxable income and do not have access to market financing, but may suffer from governance problems associated with capture by interest groups, especially if programmes lack transparency and are not adequately evaluated, and funding is not granted in a contestable manner. Tax incentives tend to be more market-oriented but create the possibility that research effort may be duplicated unnecessarily and out of line with social priorities.

Evaluating the effectiveness of fiscal incentives is difficult and requires judgment about the extent of the market failures that would prevent innovation, the social value of government-financed research and their spillover benefits for other activities. Both instruments – tax relief and direct support – suffer from potential deadweight losses.

The experience of OECD countries suggests that there has been a trend in the policy mix since the 1980s towards greater reliance on tax incentives, rather than direct government support for R&D spending. Two key factors behind this change have been a reduction in direct support for defence-related research and the need in many countries for budgetary consolidation.[1]

Empirical evidence for OECD countries is not clear-cut but suggests that tax incentives tend to be more strongly correlated with innovation activity than direct subsidies. But the effect of subsidies on innovative activity appears to depend on initial conditions. Higher direct subsidies tend to have a small positive effect on R&D intensity, especially when the corporate profit share is low, suggesting that the availability of funding from the government can help to alleviate potential financial constraints. At other times, higher subsidies are found to reduce measured innovative activity, possibly because some types of research undertaken directly for the government are more likely to be kept secret, rather than being made publicly available through patenting.

Empirical evidence is affected by the fact that it is more difficult to monitor take-up rates in the case of tax incentives than grants. Findings also seem to be stronger when based on country- or industry-level data than with micro-econometric data, possibly because the higher level of aggregation is more likely to capture broader inter-sectoral spillovers from the supported research.

1. See OECD (2003), for more information.

Support for innovation is also most effective when oriented to backward, rather than forward, linkages in the economy. This can maximise the benefits from economies of scale and geographical proximity among suppliers, improving quality and fostering human capital accumulation. As discussed in the *2003 Survey*, existing clusters have proved beneficial for participating firms in achieving scale economies, developing infrastructure and accessing new technologies. Public R&D and labour training could be used to stimulate the creation of clusters and their specific needs. Co-operation should also be fostered between businesses and universities. This can be achieved through "knowledge brokers" helping university researchers to find commercial use for their inventions. Other initiatives would include the creation of science and technology parks and incubators, but this should be carried out with great care as international evidence on the cost-effectiveness of these initiatives is far from unequivocal. A pilot programme in the Netherlands has introduced government-financed "innovation vouchers", which firms can redeem against the purchase of innovation services, as a means to foster network externalities and deepen co-operation between businesses and research institutions.

4.2. Consolidating public institutions and policies

On-going efforts to address the fragmentation and coordination problems in the delivery of government support have been insufficient. Recent initiatives to step up coordination include the *Chile Innova*[30] programme launched by the Ministry of Economy and the consolidation of CORFO's FDI and FONTEC funds into *Innova Chile*. These are steps in the right direction. But more comprehensive reform is needed, extending these otherwise piecemeal initiatives to other areas of the National Innovation System.

Reform efforts should gain renewed impetus with the creation, pending congressional approval of draft legislation, of a new National Innovation Council, attached to the Presidency, including several ministers and representatives from the academic and business communities. The Council would set goals, formulate policies, rationalise existing programmes and create incentives to foster co-operation between and within the private and public sectors. The experience of OECD countries with different institutional set-ups is instructive (Box 4). Again, governance challenges should not be underestimated, because the creation of an additional institution in an already complex set-up, without the appropriate rationalisation of the existing instances for policymaking and the delivery of government support, may do little to address the problem of fragmentation and overlapping of functions and responsibilities.

4.3. IPR, copyright and venture capital

The main policy objective with regard to copyrights should be better enforcement. With regard to IPR protection, the new IPR law is a considerable improvement and is expected to facilitate enforcement by permitting dispute resolution through civil procedures. But the ultimate test of reform in this area will be implementation. Additional supporting measures could include stricter sanctions for non-compliance to discourage infringement of the copyright and IPR legislation. More coordinated action by the police, the customs authorities and the judiciary could do much to step up enforcement in manufacturing and retail

30. The following institutions participate in *Chile Innova*: CORFO, CONICYT, Ministry of Agriculture (FIA), National Institute of Norms (INN) and *Fundación Chile*. *Chile Innova* has been financed by a USD 100 million loan from the IADB and the same amount by the government. Priority areas (*e.g.* biotechnology, ICT and competitiveness in small and medium enterprises, SMEs) and sectors (*e.g.* agriculture, fishing, wood industry, renewable energy, *e*-education and tourism) have been identified in response to a survey among stakeholders in the public and private sectors. Prior to *Chile Innova*, there were two main coordination efforts: the Science and Technology Programme (1992-95) and the Technological Innovation Programme (1996-2000). The first focused on basic research and had as participants FONDECYT, FONDEF, and FONTEC. The second emphasised innovation and included the same membership as the previous programme, as well as the Ministry of Agriculture.

distribution, tighten border controls and reduce street sales of pirated materials. The implementation of Chile's free trade agreements with the European Union and the United States is expected to call for stricter law enforcement. With regard to the processing of patent applications, the doubling of staff of the Industrial Patent Department of the Ministry of Economy is expected to make patent applications speedier. But this department could be granted operational autonomy with its own professional staff and resources, in line with trends in OECD countries.

Box 4. **National Innovation Systems: The case of Australia, Finland, New Zealand and Sweden**

In **Australia**, the Science, Engineering and Innovation Council oversees the country's national innovation system. The Council is chaired by the Prime Minister. Members include Cabinet ministers, leading researchers and the business community. A major programme is *Backing Australia's Ability*, which runs through 2010-11 and builds on an initial programme implemented in 2001. The programme focuses on three main goals: *i)* favouring R&D, mainly through the Australian Research Council and its National Competitive Grants Programme, and supporting collaborative networks; *ii*) accelerating the commercial application of ideas, with support for competitive research, technology diffusion and early-stage commercialisation activities; and *iii*) developing and retaining skills, through improving the quality of science, mathematics and technology teaching and learning at schools, new university places with a priority on ICT programmes, and increased awareness of the importance of science and technology in Australian society.

Since the mid-1990s, the **Finnish** national innovation system has attracted international attention. It is characterised by strong leadership from the Science and Technology Policy Council (STPC), established in 1987, which is in charge of the development and coordination of national policies. The Council is headed by the Prime Minister. STPC members include the Ministers of Science and Technology and Finance; senior management from universities, public research and technological institutes; the business sector; and representatives from employers' and employees' organisations. The National Technology Agency (TEKES) is the main source of public funding for applied research and industrial R&D. It operates under the Ministry of Trade and Industry but enjoys considerable policymaking and operational autonomy. The Academy of Science and Letters promotes scientific and scholarly research.

In **New Zealand**, public funds are administered by a number of public institutions: the Foundation for Research, Science and Technology (FRST), the Royal Society of New Zealand, the Health Research Council, the Ministry of Research Science and Technology, the Tertiary Education Commission, the Ministry of Education, New Zealand Trade and Enterprise and the Venture Investment Fund. Most funds are allocated on a contestable basis to universities, public laboratories (Crown Research Institutes, CRIs) and private firms, which can bid for FRST funds. The funds are allocated to those projects having the highest knowledge spillovers for the country as a whole. CRIs are increasingly oriented towards applied research and receive one-half of their revenue from FRST and the remainder from other government agencies and private sources. CRIs are expected to earn a return on assets to cover the cost of capital and are encouraged to patent the intellectual property resulting from their research. In 2002, around 20% of R&D carried out by CRIs and government departments was funded by business, against an OECD average for comparable institutions at 9.3%.

In **Sweden**, innovation policy is coordinated by the Ministries of Education and Science, and Industry, Employment and Communication, although other ministries also support innovation activities. Decision-making and implementation is carried out through formal mechanisms and informal networks at the ministerial and agency levels. The Research Advisory Board, which is chaired by the Minister of Education and Science and includes representatives from the research community and industry, plays the main coordinating role. Funding for research is provided by the Swedish Research Council and the Swedish Agency for Innovation Systems (VINNOVA), with the latter focusing on applied research. Sweden has numerous innovation-oriented partnerships among R&D-intensive manufacturing groups, public agencies and universities.

Source: Australia: Department of Education, Science and Training (2005); Finland: OECD (2005*b*); New Zealand: OECD (2004*b*); Sweden: European Commission (2004).

Development of the venture capital industry would benefit from further capital market reform. Prudential regulations on pension and mutual fund investment in these markets have been eased over the years. The further deepening of capital market reform, through *MK II*, currently in Congress, would therefore be welcome. But further development is contingent on the demand for funds, which should increase with private innovation activity in general. The government can also contribute in this area, predominantly through technical assistance and initiatives to improve entrepreneurial education at universities and business programmes, and the quality of business plans, under CORFO's Technical Assistance Fund and training of consultants. Other possible initiatives include the establishment of networks of business incubators to exchange information on best practices, and a reform of CORFO's seed and risk capital funds.

Box 5. **Summary of the main recommendations**

General principles

- Focus policy on long-term planning, fostering business-financed innovation, and facilitating the diffusion of innovation. Encourage cooperation between businesses and research institutions.
- Prioritise areas with greatest backward, rather than forward, linkages in the economy and in line with Chile's comparative advantages.

Government support

- Avoid "picking winners" in dynamic sectors that already have access to financing for innovation and/or technological transfers from parent companies abroad. Target direct government support to firms that have limited access to external financing.
- Reduce fragmentation and duplication in the delivery of government support.
- Improve the governance and cost-effectiveness of innovation funds by strengthening project evaluation and allocating funds on a contestable basis. Better disseminate information on the public resources available to promote innovation.

Higher education and vocational training

- Continue to facilitate access to higher education, especially for students from low- and middle-income households.
- Step up efforts to improve quality through the accreditation of higher-education institutions. Consider the option of making accreditation compulsory.
- Make vocational training more attuned to market demand.

IPR protection and risk/venture capital

- Improve the enforcement of copyright protection and speed up the processing of patent applications.
- Develop risk and venture capital through further capital market reform. Work towards congressional approval of the Capital Market Reform (*MK II*) package.

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Annex A1

Budget outlays for public R&D, 2002

Established in	Ministry/Agency	2002	
		In million CLP	Share (in %)
	Ministry of Agriculture	**13 218**	**7.5**
1981	Agragrian Innovation Foundation (FIA)	3 450	2.0
1964	Agriculture and Livestock Institute (INIA)	6 955	4.0
1965	Forestry Institute (INFOR)	934	0.5
1985	Natural Resource Research Institute (CIREN)	185	0.1
1976	*Fundación Chile*	1 627	0.9
2001	Improvement of Genetics Programme	67	0.0
	Laboratory for Reference Residuals	1	0.0
	Ministry of Economy	**28 511**	**16.2**
1991	FONTEC[1]	6 753	3.8
1995	Development and Innovation Fund (FDI CORFO)[1]	8 506	4.8
2001	Technological Innovation Fund Bio-Bio	516	0.3
2001	*Chile Innova* Programme		
	Research, development and innovation programme	1 201	0.7
	Agrarian Innovation Foundation (FIA)	903	0.5
	CONICYT	2 496	1.4
	National Standardisation Institute (INN)	457	0.3
	CORFO	5 040	2.9
	Fundación Chile	526	0.3
1991	Fisheries Research Fund (FIP)	933	0.5
1965	Fisheries Promotion Institute (IFOP)	401	0.2
1976	*Fundación Chile* (CORFO)	..	..
1985	Information Centre for Natural Resources (CIREN)	226	0.1
	Adm Abate Molina	536	0.0
	Investment Studies	..	..
	Fishing research programme of the swordfish	15	0.0
	Ministry of Education	**114 834**	**65.4**
	Public support for university R&D[2]	68 114	38.8
1982	FONDECYT	22 151	12.6
1991	FONDEF[1]	10 269	5.8
1988	National Postgraduate Grants Programme	3 042	1.7
1967	CONICYT	3 265	1.9
1978	Astronomic Institute Isaac Newton	54	0.0
2001	Regional Programmes for Scientific Research	528	0.3
1999	Improvement for quality and equity in higher education[3]	7 405	4.2
	Gemini-Aura Agreement	7	0.0

Budget outlays for public R&D, 2002 (*cont'd*)

Established in	Ministry/Agency	2002	
		In million CLP	Share (in %)
	Ministry of Planning	**7 986**	**4.5**
1999	*Millenium* Scientific Initiative	3 919	2.2
1999	National Postgraduate Grants Programme	390	0.2
1981	International Postgraduate Grants Programme	3 677	2.1
	Ministry of Mining	**4 448**	**2.5**
1964	Chilean Nuclear Energy Commission (CCHEN)	4 194	2.4
	National Service for Geology and Mining (SERNAGOMIN)	254	0.1
	Ministry of Public Works, Transport and Communications	**485**	**0.3**
1953	National Hydrolic Institute	410	0.2
	Ministry of Defence	**1 655**	**0.9**
1922	Military Geographical Institute (IGM)	824	0.5
	Hydrographic and Oceanographic Service (Navy)	764	0.4
	Air photographic service (Air Force)	68	0.0
	Ministry of Foreign Affairs	**1 583**	**0.9**
1963	Chilean Antarctic Institute (INACH)	1 583	0.9
	Other	**2 976**	**1.7**
1987	Tax deductions for research projects	1 884	1.1
	Others[4]	1 091	0.0
	Total	**175 696**	**100.0**

1. Includes administrative costs.
2. Based on an estimation of the share of funds allocated to higher-education institutions that is devoted to financing R&D according to the Canadian rule.
3. Allocations to post-graduate students.
4. Includes R&D spending by Air Force (FACH), Centre for Military Studies (CESIM), Hospital of the University of Chile, Meterological Service of Chile, and National Fund for Regional Development (FNDR).

Source: CONICYT.

Annex A2

Innovation Surveys

This Annex reports more detailed information based on INE's *Innovation Surveys*, conducted in 1994-95, 1997-98 and 2000-01. The sectors covered are manufacturing, mining, and electricity generation and distribution (Table A2.1). Attention is focused on the 2000-01 wave because the previous ones only covered manufacturing and did not include information on spending on machinery and equipment embodying new technology. Information is also available on the sources of funding for spending on innovation (Table A2.2).

Table A2.1. **Private innovation spending, 2001**
In millions of CLP

Expenditure	Sector				All
	Manufacturing	Electricity generation	Electricity distribution	Mining	
Total innovation spending					
Spending	393 243	3 139	6 698	40 414	443 494
Per establishment	83	37	140	697	90
R&D					
Spending	42 494	138	26	4 519	47 177
Per establishment	9	2	1	78	10
Standard Deviation	8 019	81	13	1 209	8 134
Labour training					
Spending	18 203	25	130	584	18 942
Per establishment	4	0	3	10	4
Standard Deviation	7 904	14	55	224	7 911
Trials, licenses and patents					
Spending	10 845	2	169	94	11 109
Per establishment	2	0	4	2	2
Standard Deviation	2 256	2	142	60	2 267
Acquisition and installation of new technology equipment and machinery					
Spending	321 700	2 974	6 374	35 218	366 265
Per establishment	68	35	133	607	74
Standard Deviation	65 200	2 218	4 094	16 100	67 500

Source: *Chile Innova* (2003).

Table A2.2. **Sources of funds for private R&D spending, 1998, 2001**
In % of establishments

	Manufacturing 2001	Manufacturing 1998	Electricity Generation 1998	Electricity Distribution 1998	Mining 1998
	Source of funds for innovation over past three years				
Exclusively own funds	56.8	66.1	90.0	68.2	76.3
Exclusively public funds	0.3	0.1	0.0	0.0	2.6
Exclusively private external	3.3	1.5	3.3	0.0	5.3
Own and private external	26.8	28.6	6.7	9.1	10.5
Other combinations	12.9	3.7	0.0	22.7	5.3

Source: *Chile Innova* (2003).

Annex A3

Technology Funds and Science and Technology Programmes: A summary

Name	Created in	Ministry of:	Goals and activities
(a) Innovation funds			
Innova Chile	2005	Economy	Promote and facilitate private innovation in four areas (general purpose technology, business innovation, technology transfer, and business start-ups), with a focus on biotechnology, ICT and agribusiness.
Scientific and Technological Development Promotion Fund (FONDEF)	1991	Education	Strengthen scientific and the technological capabilities of universities and technological institutes to increase firm competitiveness.
National Science and Technology Development Fund (FONDECYT)	1981	Education	Foster basic scientific and technological research.
Agrarian Innovation Foundation (FIA)	1981 (reactivated in 1994)	Agriculture	Promote innovation to boost competitiveness in agriculture.
Innovation fund for the Bío-Bío region (INNOVA Bío-Bío)	2002	Economy/Interior	Promote innovation and transfer of technology in the Bío-Bío region by developing the region's competitiveness, with the aim of creating new sources of employment.
Fisheries Research Fund (FIP)	1991	Economy and Energy	Provide scientific and technical information for the management of fishing resources.

Technology Funds and Science and Technology Programmes: A summary (*cont'd*)

Name	Created in	Ministry of:	Goals and activities
(b) Science and technology programmes			
Technology Development and Innovation (*Chile Innova*)	2001	Economy (with Agriculture and Education)	Increase competitiveness of SMEs by supporting innovation in ICT, biotechnology and new technologies. It aims to articulate and coordinate the various public R&D support mechanisms used by different institutions (CORFO, CONICYT, FIA, INN and *Fundación Chile*), under the auspices of the Ministry of Economy and with support from the IADB. Programme ends in 2005.
Brands and Patents	..	Economy	Disseminate information on intellectual property (*e.g.,* brands, patents).
Science for the Knowledge Economy	2003	Education	Encourage interaction between public and private innovators and develop human capital directed at science and technology (financed by the World Bank).
Millennium Scientific Initiative	1999	Planning	Promote PhD students and postgraduate researchers to participate in international networks.
Explora	1995	Education	Disseminate scientific and technological developments among children and youth.
Bicentenary	2004	Education	Foster the development of a knowledge-based society by promoting business investment in science and innovation and participation in global science and technology networks.
(c) Grant programmes			
National Postgraduate Grants	..	Education	Promote the development of Master and Doctoral programmes.
International Postgraduate Grants	1981	Planning	Foster specialisations abroad for Masters, PhD and specialisation studies for civil servants, academics and recent graduates of universities or professional institutes.

Technology Funds and Science and Technology Programmes: A summary (*cont'd*)

Name	Created in	Ministry of:	Goals and activities
(d) Technological institutes			
Agriculture and Livestock Research Institute (INIA)	1964	Agriculture	Foster applied research and development, dissemination and transfer of technology transfer for agriculture and livestock sector.
Forestry Institute (INFOR)	1965	Agriculture	Provide information and technology for efficient resource allocation and a sustainable use of forestry resources.
Natural Resource Research Centre (CIREN)	1985	Agriculture	Provide information on natural resources, including climate; hydro, fruit and forestry resources; soil use and potential; mining and geology; and geomorphology; carry out environmental impact assessments of new companies and projects.
Fisheries Promotion Institute (IFOP)	1965	Economy and Energy	Regulate the fisheries and aquiculture industries, while preserving the hydro-biological ecosystems.
National Standardisation Institute (INN)	1973	Economy and Energy	Carry out standardisation, certification and metrology.
Chilean Nuclear Energy Commission (CCHEN)	1964	Mining	Study the challenges of production, acquisition, transfer, transport and peaceful use of nuclear energy.
Hydro-graphic and Oceanographic Service of the Chilean Navy (SHOA)	1990	Defence	Ensure the security for shipping lanes, inland channels and lakes, territorial waters and seaways off the Chilean coast.
Military Geographical Institute (IGM)	1992	Defence	Carry out geographical and cartographical studies.
Chilean Antarctic Institute (INACH)	1963	Foreign affairs	Plan and carry out scientific, technological and environmental activities in Antarctica in coordination with the National Antarctic Program.
National Hydraulic Institute	1953	Public Works	Carry out studies on the security and efficiency of future hydraulic infrastructure projects.
National Service for Geology and Mining (SERNAGEOMIN)	..	Mining	Provide technical advice on geology and mining.
Fundación Chile	1976	Private non-profit, with government participation	Transfer state-of-the-art technology, management techniques and human skills to natural resource-intensive sectors.

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